C Squared Systems, LLC
65 Dartmouth Drive
Auburn, NH 03032
Phone: (603) 644 2800
support@csquaredsystems.com

August 23, 2017

Town of Edgartown
Edgartown Planning Board
70 Main Street
Edgartown, MA 02539

RE: *New Cingular Wireless PCS, LLC (AT&T) special permit to construct a 117 foot monopole at 14 Sampson Avenue and their response to the Planning Board's request for additional information concerning the use of a stealth "unipole" tower in lieu of the standard proposed monopole design.*

Dear Planning Board Members:

On behalf of AT&T with respect to the above-referenced special permit application, (the "Application") below is AT&T's response to the Board's request for additional information supporting their inability to utilize a 117-foot concealed monopole or "unipole" antenna supporting structure in lieu of the standard 115 foot monopole design, as proposed in their current Application.

The attached supplemental information explains why a concealment monopole ("CMP") or "unipole" will not accommodate AT&T's antenna system design, both from a dimensional perspective and a system performance perspective, and why a standard external antenna array is the only viable configuration to meet AT&T's site design requirements for Chappaquiddick and Edgartown.

Attachments Enclosed:

Sincerely:

Dan Goulet
RF Engineer, Representing AT&T

cc: Brian Grossman, Esq., Anderson & Kreiger
Dan Bilezikian

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I. OVERVIEW

Whether you call them flagpoles, stealth monopoles, slim-line poles, "slick sticks" or other, the concealed monopole or "CMP" has been a useful tool for municipalities and carriers attempting to minimize the aesthetic impact of traditional communications towers. While CMPs have always limited the structural and dimensional capacity of a tower, that was rarely a challenge for 2G and 3G network configurations using tower mounted amplifiers ("TMA") and running one or two frequency bands. However, with the advent of 4G LTE and the availability of progressive antenna technologies like "MIMO" (Multiple Inputs Multiple Outputs) and 4-Branch Diversity Receive, combined with the fact that carriers are utilizing three or more of their licensed frequency bands, the physical limitations of CMP's not only preclude the carriers from taking advantage of the aforementioned technologies, they limit the operator's ability to utilize all of their licensed spectrum.

Concealed monopoles look like a traditional monopole tower, but without the exterior platforms mounts and antennas attached at the top. The top 20 to 50 feet of a CMP tower consists of a series of vertically stacked canisters. Inside these canisters is a narrow spine with "spoke" fittings at each end that connect to the tower base and allow stacking of additional canisters. Antennas and small amplifiers are mounted vertically to the spine. Cables connecting the antennas to equipment at ground level are routed through the fittings then down the base of the tower. Once the carriers' equipment is installed, RF passive material is wrapped around the fittings to shield the antennas and cabling from view. The spine ranges from 7"-12" in diameter, while the exterior canister is 30"-42" in diameter. This leaves a vertical space with a depth of 12" to 15" inches to install antennas, amplifiers and cables. Figure 1 offers a more detailed illustration of a typical canister design.

Figure 1: CMP Prior to Installation

The CMP's aesthetic functionality comes at a cost to structural capacity and useable equipment space. The narrow spine and "butt joint" connections drastically reduce the weight loads that can be installed on the tower. The limited vertical space between segments, and horizontal space between the spine and covering, allows for only three antennas and supporting equipment to be installed within each canister segment.

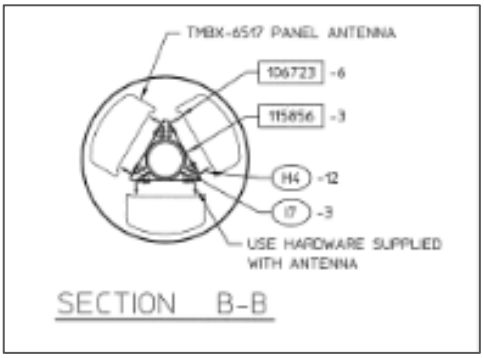

Figure 2: Illustration of Antennas inside the CMP

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II. AT&T EQUIPMENT REQUIREMENTS FOR 4G LTE:

The introduction of 4G (4th Generation) LTE or "Long Term Evolution" in 2011 brought with it radically improved data speeds and high definition voice over its 2G and 3G predecessors. In addition to a simplified and more efficient network architecture, LTE also changed the type and configuration of equipment used to support the network. The 4G LTE cell site design calls for the use of fiber fed Remote Radio Heads ("RRH") installed adjacent to or near the antenna and the use of MIMO antenna technology. The RRH-based design with "MIMO" offers countless benefits that maximize the capacity, coverage, quality, speed and efficiencies of 4G LTE - exactly what technology enhancements are about.

The RRH essentially moves components (amplifiers and RF circuitry) previously located in the Base Transceiver Station ("BTS") up the tower to be closer to the antenna, and leverages fiber optic transport to the BTS to drastically reduce signal attenuation (loss) in both the uplink and downlink. (Reference Figure 3).

Figure 3: RRH's Positioned behind the Antennas

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In older 2G and 3G systems, the radio amplifiers and circuitry were within the BTS and fed the antennas and tower mounted amplifiers (TMA's) with up to 18 thick coaxial cables. Older systems implementing MIMO ("Multiple Inputs, Multiple Outputs"), which multiplies capacity within the communications circuit, essentially required double the coaxial cables. With RRHs located behind the antennas and connected to the BTS via fiber, the coaxial cable runs are eliminated, simplifying the installation requirements.

The combined effect of eliminating coax loss and adding capacity with "MIMO" and gain with 4-branch diversity receive, results in a drastic improvement to network performance:

- Extends the "true" reach of the cell site
- More than doubles cell site capacity
- Improves voice quality and data speeds
- Improves handset battery life
- Improves handoffs between cell sites

To achieve these benefits, however, the tower itself needs to support greater equipment loads and be able to spatially accommodate both the equipment required and the interconnecting antenna system coaxial cables or fiber.

As 4G technology has been implemented, older towers of all types have been upgraded or replaced, and new towers are built with this reality in mind. The challenge, however, is working with municipalities to accommodate the upgrades, especially in communities that mandate the use of more restrictive structures like concealed monopoles. AT&T's current design for Chappaquiddick requires 9 antennas (three per sector) mounted on a triangular platform at the top of the tower with RRH's mounted on each antenna pipe mount, behind the antennas.

III. CMPs AND 3G

Concealed monopoles make use of advancements in antenna combining technology. Smaller antenna elements and cross polarization made it possible to stack the antenna elements of multiple frequency bands ("multiband") in a single 6' to 8' panel antenna. (Reference Figure 4 below.)

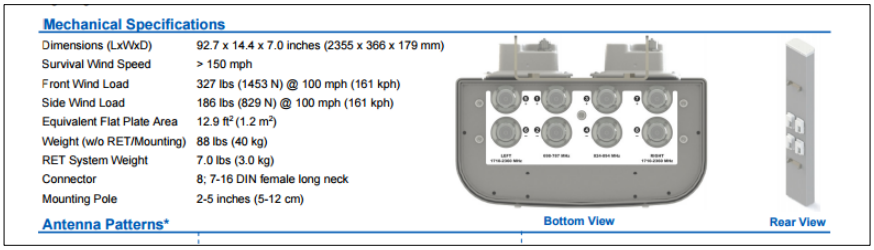

Figure 4: CCI Octo-Port antenna supporting 4 frequency bands

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For 3G equipment configurations using long coax runs and TMAs, the width and depth of these multi-band antennas allowed for three (3) antennas to be attached around the spine at a single elevation inside the concealment with sufficient room for mounting brackets, cable connections and pass through of cables to elevations above. (Reference Figure 5.)

This configuration, while feasible, comes with sacrifices in RF performance (loss) and operational limitations. As stated previously, use of 4-branch diversity and MIMO is practically impossible, without requiring additional elevations for a separate set of antennas and associated equipment. The operational disadvantages of this design include:

- Single point of failure by sector
- Eliminates design flexibility
- Limits future upgrades

Figure 5: CMP without Covering

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IV. CMPs and 4G LTE

Considering the restrictions on 3G equipment configurations, it is easy to recognize the even greater impact on 4G LTE. While the antenna elements of different frequencies can be combined in a single enclosure, RRHs cannot. The RRHs weigh 40 to 70 lbs. and are roughly 3 to 5 times the physical size of the TMAs used in 3G configurations. They require sufficient airflow to cool the active elements inside, and a Carrier will require up to 12 to support the frequency bands operated[1]. As illustrated in Figure 5, there just isn't sufficient room in the CMP to support the equipment requirements without significant and detrimental modification to the structure and its shielding elements.

Figure 6: CMP Close-up

When forced to use a CMP, carriers must sacrifice many of the technological and performance benefits of 4G LTE. The disadvantages of locating the RRH's at ground level are listed below:

- Replace efficient fiber runs with coaxial cables introducing loss in the uplink and downlink
- Add Tower Mounted Amplifiers as a fourth tier to compensate for the additional signal losses incurred by the introduction of lengthy coax.
- Marginalizes use and value of higher frequency bands (PCS, AWS, WCS Bands)
- Limits use of MIMO and 4-branch diversity capabilities
- Reduces data speeds and cell site reach
- Reduced collocation capacity

An AT&T installation utilizing 4-branch diversity and MIMO but limited to a CMP design would require the RRHs to be located within the proposed leased space of the shelter and connected to the antennas via the underground conduit and would require the need for eighteen (18) 1 5/8" coaxial cable runs from the RRHs to the antennas, in lieu of fiber.

For the Chappaquiddick facility, AT&T would require three successive vertically spaced bays within the monopole, each bay accommodating three antenna and associated TMA's, which must now be added to compensate for the losses associated with the coaxial cable incurred by the elimination of the fiber transports. Assuming the planned tower height remains the same (115'), the centerline of AT&T's third tier of internally mounted antennas would be 30' lower than the original design centerline. Compensation for the loss in coverage by this height reduction can only be achieved by increasing the overall height of the CMP.

This reduction in height not only impacts the coverage and capacity for AT&T, restricting MIMO and future system performance optimization capabilities, it also minimizes collocation opportunities, most notably for the planned Verizon Wireless facility and any existing Chappy WISP wireless tenants intent on relocating their antennas to the new tower. Using multiple elevations for a single operator drastically reduces tower capacity. This becomes especially challenging in communities where land available for

[1] Most cell sites use a three (3) sector configuration for each frequency band operated by the Carrier (700 MHz, 800 MHz, 1900 MHz PCS, 2100 MHz AWS and 2500 MHz WCS) to provide 360 degree coverage from a cell site. Each sector of each frequency band is fed by a dedicated RRH.

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tower sites is scarce. The reduction in tower capacity increases the likelihood of the need for additional towers on Chappaquiddick.

Table 1 below shows the antenna and TMA centerlines associated with the suggested CMP design and the equivalent CMP tower height requirement necessary for AT&T and Verizon Wireless to meet their respective coverage objectives. In reviewing Table 1 it is important to note that the resulting bottom tier centerlines for AT&T would conflict with the Chappy WISP antenna centerlines required on the planned replacement tower. From this table it should also be noted that without a substantial increase in the height of the CMP, Verizon's top tier antennas are in close proximity to the tree line, potentially reducing the suitability of this site for collocation.

	Description	Elevation Bay 1	Elevation Bay 2	Elevation Bay 3	Elevation Bay 4	Monopole Design Height/ Centerline	CMP Antenna Height	Delta	CMP Equiv. Height Rqmt.
AT&T	Top of Antenna	115	102	89	N/A				
	Tier 1 Ant Centerline	110.5	97.5	**84.5**	N/A	115	84.5	30.5	146
	Bottom of Ant	106	93	80	N/A				
	Top of TMA	105	92	79	N/A				
	Bottom of TMA	103	90	77	N/A				
Verizon	Top of Antenna	**67**	58	49	40				
	Tier 1 Ant Centerline	63	54	45	**36**	100	63	37	152
	Bottom of Ant	59	50	41	32				

Table 1: CMP Impact to Tower Height

It is also important to note that some of the antennas relocating to the proposed tower cannot be internally mounted. The microwave dishes and omnidirectional antennas used by Public Safety and other operators must be mounted to the exterior of the monopole.

V. CMP's and the Impacts on System Performance:

The above information explains why a concealed monopole configuration or "unipole" design is not a viable option for AT&T from equipment and dimensional perspectives. The below addresses why the CMP design is not a viable solution for AT&T from a performance and network optimization perspective.

As new sites are integrated into the existing network, it is important to be able to maintain a balance between overall geographic coverage area the site will serve and the ability to support the usage within the coverage footprint. Key to the integration and system optimization process is the ability to change antenna azimuths or sector orientations to effectively alter or adjust the coverage footprints of specific serving sectors. This capability is essential to maintaining reliable communication through coverage optimization and load distribution for existing and new sectors, and is an ongoing process. The limited space within the CMP restricts azimuth adjustments for the panel antennas to 110° maximum offsets, effectively preventing the use of non-standard azimuths and impairing network optimization.

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VI. SUMMARY:

As stated in our RF Report and during the first presentation to the Board, the objective of the proposed facility is to fill in significant coverage gaps and provide the network capacity needed within Edgartown, during both peak and off-peak seasons.

While there may be instances where CMPs were deployed in new tower construction, those instances were typically the result of a municipal mandate implemented well before 4G LTE was in use. With 4G LTE established as the de facto standard for wireless voice and data, any CMP mandate, whether or not combined with other restrictions on height or location, effectively prohibits licensed carriers from deploying these technologies with the equipment configurations required to fully support their licensed services.

At our last meeting the Board requested quantitative information regarding the impact of the CMP (aka: flagpole or unipole) design on coverage, capacity, and overall system performance. Unfortunately, the impact of a CMP design in lieu of a standard monopole design cannot be effectively shown with comparative plots or coverage statistics. The 10 dBm threshold ranges utilized on the plots has the effect of "masking" areas of signal decreases, showing color variations only in areas where a "range change" occurs.

Of greater significance is the fact that the CMP design with its associated dimensional constraints severely limits the flexibility needed by AT&T to optimize their network and their ability to address ongoing system performance related issues; both of which are fundamental requirements as new sites are integrated into the network. In addition, the use of a concealed monopole reduces collocation capabilities which potentially increases the number of additional towers required to meet each carrier's coverage objectives.